Malnutrition results when nutritional intake does not meet metabolic requirements. Critically ill patients are at an increased risk for malnutrition because of alterations in protein and energy metabolism displayed in response to trauma, major surgery, burns, and sepsis and may be unable to tolerate oral nutrition. Critical care nurses are well positioned to screen patients at risk for malnutrition and to work in conjunction with the multidisciplinary team to develop and implement interventions to prevent and treat malnutrition.

Malnutrition is common in critically ill patients and is associated with poor outcomes for patients and increased health care spending. Enteral nutrition is the method of choice for nutrition delivery. Enteral nutrition delivery practices vary widely, and underfeeding is widespread in critical care. Interruptions in enteral nutrition due to performance of procedures, positioning, technical issues with feeding accesses, and gastrointestinal intolerance contribute to underfeeding. Strategies such as head-of-bed positioning, use of prokinetic agents, tolerance of higher gastric residual volumes, consideration of postpyloric feeding access, and use of a nutrition support protocol may decrease time spent without nutrition. (Critical Care Nurse. 2014;34[4]:14-22)
Malnutrition in critically ill patients is associated with increased costs to both the patient and the health care system. Risk for malnutrition at admission and worsening nutritional status during hospitalization are strongly associated with prolonged length of stay, increased cost of hospitalization, and higher mortality. Malnutrition in hospitalized patients also is associated with the development of pressure ulcers and an increased incidence of infection, as well as difficulty weaning from mechanical ventilation.

The cost of treating a patient with disease-related malnutrition has been estimated at 20% higher than treating a patient without malnutrition. The Centers for Medicare and Medicaid Services have designated hospital-acquired conditions such as catheter-related infections and the presence of stage III or IV pressure ulcers that develop during hospitalization as conditions that do not qualify for payment, leaving hospitals and providers to bear the financial burden.

Internationally, the reported prevalence of malnutrition varies from 22% to 43% in hospitalized patients. In a follow-up study of intensive care unit (ICU) patients, Kvale et al reported that 40% of patients included in the study lost more than 10 kg (22.2 lb) of weight during and in the period directly after ICU admission. Older patients, those with malignant disease, and patients receiving polypharmacy are at increased risk for the development of malnutrition while hospitalized.

Malnutrition remains underreported in hospital settings, preventing patients from receiving appropriate treatment including nutrition assessment and intervention. According to the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.), hospitalized patients should be screened for malnutrition risk upon admission, followed by performance of a nutrition assessment for those identified as at risk of malnutrition. Screening methods vary in level of detail and ease of use and seek to identify patients who require more in-depth assessment. Commonly performed anthropometric and laboratory values used in screening and assessment are displayed in Table 1.

### Table 1. Laboratory and anthropometric values indicating malnutrition

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value indicative of malnutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass index$^a$</td>
<td>&gt;19 to &lt;22, at risk; &lt;18.5, malnourished</td>
</tr>
<tr>
<td>Unintentional weight loss</td>
<td>&gt;10% body weight in past 6 months or &gt;5% in past 3 months</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>&lt;3.5 g/dL</td>
</tr>
<tr>
<td>Prealbumin</td>
<td>&lt;16 mg/dL</td>
</tr>
</tbody>
</table>

$^a$ Calculated as weight in kilograms divided by height in meters squared.

### Enteral Nutrition Delivery

Enteral nutrition delivery is the feeding method of choice in critically ill adult patients. Infectious complications are more often associated with parenteral nutrition than with enteral nutrition. The administration of enteral nutrition aids in the restoration of intestinal motility, maintains gastrointestinal integrity and function, minimizes the translocation of bacteria and other organisms, improves wound healing, and decreases the incidence of infection.

Aspiration is the most serious complication of enteral tube feeding and is the leading cause of pneumonia in ICUs, contributing to increased morbidity and mortality in critically ill patients. Such patients are at increased risk for aspiration because of clinical conditions that occur in the ICU, including altered swallowing mechanisms due to mental status changes, medications, recent endotracheal intubations, and diminished protective cough mechanisms.

Gastrointestinal complications associated with enteral feeding include high gastric residual volumes (GRVs), constipation, diarrhea, abdominal distention, and vomiting; these complications are present in more than...
half of all patients receiving enteral nutrition via nasogastic access. In 15.2% of patients with reported complications, complications were not controllable and enteral nutrition was discontinued.20

The practice of delivering enteral nutrition varies broadly,21 even within a single hospital.22 Despite strong evidence that early enteral feeding, within 24 to 48 hours of admission, is beneficial to critically ill patients,23-26 the mean time to enteral feeding remains high at 46.5 hours from admission to initiation of feedings.27

Critically ill patients who receive enteral feeding commonly do not achieve nutritional targets.22,28 Results of a large international multicenter study27 involving patients receiving mechanical ventilation and enteral nutrition indicated that patients were receiving only 59% of their energy needs and 60% of their protein needs. Currently adequate feeding is not well defined in the literature, and further research exploring the relationship between energy and protein deficits and patients’ outcomes is warranted. Increasing energy and protein intake in critically ill patients to prescribed levels decreases mortality,29 and bloodstream infections are more common in critically ill patients who do not receive at least 25% of their recommended kilocalories.30 In another study evaluating the link between caloric intake and clinical outcomes, researchers reported that patients who received a moderate caloric intake (33%-65% of the prescribed target) had better clinical outcomes than did patients who received higher intake.31

**Interruption of Enteral Nutrition**

Interruption of enteral nutrition is common. Mean time of feeding interruption per patient has been reported as more than 5 hours per patient per day in critically ill adults.32 Frequently cited reasons for the interruption of enteral nutrition include procedures, positioning, technical issues with feeding accesses, and gastrointestinal intolerance issues.

**Procedures**

Routine interruption of enteral nutrition before procedures and surgeries is common. Feedings are withheld in an attempt to prevent aspiration of stomach contents during extended periods of positioning with a head-of-bed (HOB) position less than 30º or during placement of an artificial airway. If anesthetics or sedatives are administered, reinitiation of enteral feeding may be delayed during recovery from the procedure. The most frequently cited reason for interruption of enteral feeding is for procedures and operations.22,32 Enteral feedings may also be withheld in anticipation of extubation or in anticipation of future reintubation. According to O’Leary-Kelly et al,33 more than 50% of interruptions in enteral nutrition were due to planned procedures or extubations. Scheduling of procedures and operations has also been cited as a reason for interruptions in and delay in resumption of enteral feedings. Scheduling influenced the delivery of enteral nutrition because the variability in the surgical schedule led to increased fasting times.34 No clear guidelines exist to guide the withholding of enteral nutrition before procedures in critically ill patients.22 Because of the increased risk of aspiration pneumonia and its complications in critically ill patients, the current practice of withholding feedings before procedures in critically ill patients who require enteral nutrition is recommended.35,36

**Positioning**

Positioning also contributes to inadequate delivery of enteral nutrition. Nurses often place patients in positions with the head of the bed lowered throughout the shift to perform care, which requires that enteral feedings be withheld and thus limits the amount of enteral nutrition delivered. Although these interruptions are common, they account for only a small portion of the time spent without enteral nutrition.33,34 In 1 study,34 these interruptions accounted for only 2.3% of the total interruption time but were the most common reason for interruption.

**Technical Issues With Feeding Accesses**

Technical issues with feeding accesses also contribute to interruptions in enteral nutrition, accounting for 25.5% of the total time for interruption of enteral nutrition.34 Enteral feeding accesses may become clogged or dislodged, preventing the delivery of enteral nutrition.31,34 Patients may wait long periods of time for a feeding tube to be placed31 and subsequently for a provider to confirm accurate placement.34 O’Meara et al34 reported that a need for frequent repositioning of the small-bore feeding tube was common, with 29% of patients requiring 1
additional insertion after initial confirmation of tube placement, 14% requiring 2 reinsertions, and 17% requiring more than 2 reinsertions.

Intolerance of Enteral Nutrition
Intolerance of enteral nutrition, including nausea, vomiting, and high GRVs is also commonly cited as a reason for interruption of enteral nutrition. Specific determination of what constitutes a high GRV is unclear in the literature, and practices for assessing and addressing high GRVs vary. Uncertainty regarding the assessment and treatment of high GRVs makes clinical decision making regarding management of GRVs difficult for practitioners.

Strategies to Address Interruptions in Enteral Nutrition Delivery
Strategies can be used by the health care team to reduce time spent without enteral nutrition (Table 2). Tactics to minimize interruptions in enteral nutrition include HOB positioning, use of prokinetic medications, use of a higher threshold when monitoring GRVs, consideration of postpyloric feeding access, and use of an evidence-based nutrition support protocol. All of these tactics can be used effectively to decrease the amount of time that critically ill patients remain without enteral nutrition.

Positioning
Critically ill patients receiving enteral nutrition are at increased risk for aspiration of gastric contents and the subsequent development of pneumonia. A low backrest elevation, less than 30º, is a risk factor for aspiration and pneumonia. Supine positioning and the length of time the patient spends supine are risk factors for aspiration of gastric contents. It is recommended that patients receiving enteral nutrition remain with their HOB position greater than 30º to 45º or be placed in reverse Trendelenberg position at 30º to 45º if the patient cannot tolerate flexion to decrease aspiration risk. Allowing patients to maintain HOB elevation while continuing enteral nutrition infusions during routine nursing care procedures will increase nutrient delivery in critically ill patients.

Use of Prokinetic Medications
Intolerance of enteral feedings, most frequently high GRVs, is commonly cited in the literature as a reason for interruption of enteral nutrition. The use of prokinetic medications such as erythromycin and metoclopramide is effective in this population at decreasing GRVs and increasing tolerance of gastric enteral nutrition. Metoclopramide is the most commonly used agent and acts by increasing antral and small intestinal motility. Erythromycin is a macrolide antibiotic that causes excitation of smooth muscle. It is less commonly used because of providers’ concerns regarding antibiotic resistance and the potential for cardiac arrhythmias due to prolongation of the QT interval.

A.S.P.E.N. recommends that promotility agents should be considered after 2 episodes of a high (>250 mL) GRV are noted. Any attempt to discontinue prokinetics after the first 3 to 5 days of enteral nutrition, or 24 to 48 hours after the target rate has been met, should be decided on the basis of the clinical scenario. Enteral administration of prokinetic agents is cost-effective, but requires systemic absorption to take effect; therefore, intravenous administration is recommended.

Assessment of and Response to GRVs
Practices for assessing and responding to high GRVs vary widely in the literature. In experimental studies, GRV did not correlate with aspiration, vomiting, or ventilator-associated pneumonia, yet it continues to be standard to routinely monitor GRVs in practice. Measurement of GRV is subjective and is affected by the patient’s position, the feeding tube diameter, the syringe size, and the clinician performing the measurement.

Table 2 Strategies to minimize interruptions in enteral nutrition

<table>
<thead>
<tr>
<th>Factor</th>
<th>Strategy</th>
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<tbody>
<tr>
<td>Head-of-bed positioning</td>
<td>30º-45º or reverse Trendelenberg positioning</td>
</tr>
<tr>
<td>Gastric residual volume</td>
<td>Assess every 4 hours</td>
</tr>
<tr>
<td></td>
<td>If &gt;500 mL, withhold feedings and assess tolerance</td>
</tr>
<tr>
<td>Prokinetic agents</td>
<td>Consider use after 2 episodes of gastric residual volume &gt;250 mL</td>
</tr>
<tr>
<td>Postpyloric access</td>
<td>Consider if gastric feeding intolerance displayed</td>
</tr>
</tbody>
</table>
According to guidelines set forth by A.S.P.E.N., GRVs should be assessed every 4 hours in critically ill patients. A GRV greater than 500 mL should result in withholding of enteral nutrition for assessment of tolerance. A patient’s tolerance to enteral feeding should be assessed, including a physical assessment, evaluation of glycemic control, minimization of sedation, and consideration of a promotility agent. Toleration of higher GRVs (>250 mL) in an effort to decrease interruption of enteral nutrition solely due to high GRVs is supported by the literature.

Consideration of Postpyloric Feeding Access

Obtaining duodenal access has been cited as a reason for delays in initiation of and interruptions in enteral feeding. Encouraging the use of gastric feeding until duodenal access can be obtained in patients without a history of alterations in gastric mobility may decrease the amount of time patients remain without enteral nutrition while attempts are made to obtain duodenal access. Studies supporting the use of gastric feedings in critically ill patients without a history of alterations in gastric mobility have shown tolerance of feedings via the gastric route. A meta-analysis of randomized controlled trials in which outcomes in critically ill patients receiving gastric feedings versus critically ill patients receiving duodenal feedings showed no difference in mortality, risk of diarrhea, length of ICU stay, or risk of aspiration or pneumonia. Conflicting evidence is provided by smaller studies with less rigorous design, where intolerance in critically ill patients receiving gastric feedings is reported. Evidence-based practice guidelines developed by A.S.P.E.N. support the use of gastric access in ICU patients unless intolerance of gastric feedings is apparent.

Blind postpyloric placement of a tube can be difficult and time-consuming. Alternatives to blind placement include nurse-driven methods such as the colorimetric carbon dioxide detector, the magnetically guided feeding tube, and the electromagnetic placement device. The colorimetric device is used to detect the presence or absence of carbon dioxide, allowing the clinician to determine gastric versus lung placement of the feeding tube. The magnetically guided feeding tube uses a magnetic device to lead the feeding tube through the gastrointestinal tract into the intestine and has been used successfully to ensure postpyloric placement. The use of an electromagnetic placement device allows the feeding tube to be visualized as it progresses through the gastrointestinal system into the intestine. This method has been used with success in patients with previously difficult access and is cost-effective, reducing X-ray exposure and time to initiation of enteral feeding.

Nutrition Support Protocols

In an effort to prevent and treat malnutrition in critically ill patients by increasing the effectiveness of nutrient delivery and reducing feeding interruptions, nutrition support protocols have been developed and implemented. Protocols to guide care in critically ill patients have been used with success in other areas, including ventilator weaning, intensive insulin therapy, and sedation management. Nutrition support protocols are effective in increasing the amount of nutrients provided to critically ill patients and decreasing the amount of time necessary to reach target nutrition goals.

The content of currently available feeding protocols varies. Based on the best evidence available at this time, a protocol that encourages the use of enteral feeding versus parenteral feeding when possible, promotes early enteral feeding, includes the use of prokinetic agents when medically appropriate, tolerates higher GRVs (≥250 mL), encourages the use of duodenal access when readily available, and seeks to minimize interruptions in feeding should be used. These recommendations are in concurrence with evidence-based practice guidelines developed by the Canadian Medical Association and A.S.P.E.N. regarding delivery of enteral nutrition in critically ill adults.

Areas for Future Research

The use of volume-based enteral feedings, which attempt to deliver a daily target during a 24-hour period, versus traditional enteral feeding, which sets an hourly target, should be explored. Daily volume-based targets allow missed feedings to be administered later by increasing the hourly rate to compensate for previous

Nutrition support protocols are effective in increasing the amount of nutrients provided to critically ill patients and decreasing the amount of time necessary to reach target nutrition goals.
reductions in feeding. A pilot study performed by Heyland et al. resulted in an improvement in nutritional delivery when a protocol that includes this method was used. Significant increases in protein (P = .002) and energy (P = .02) delivery were seen in the treatment group, with similar rates of vomiting, aspiration, and pneumonia when compared with the group receiving feedings at a consistent hourly rate. Testing in a larger sample should be performed.

Lichtenberg et al. calculated higher hourly infusion rates based on a 20-hour infusion schedule, attempting to compensate for missed feedings seen with standard 24-hour infusion schedules. Rates were calculated for 20 hours but infused for 24 hours. A significant increase in the number of patients who received their goal enteral nutrition requirements was seen (defined as ±10% of goal) as was a significant rate of overfeeding (defined as ≥110% of goal) in patients who had received enteral nutrition for more than 2 weeks, indicating a need for further evaluation.

Pousman et al. sought to evaluate a protocol to reduce fasting in trauma patients receiving mechanical ventilation. Patients were fed via gastric tube until 45 minutes before procedures or were fed via duodenal tube until the start of the procedure. A trend toward an increase in nutrition administered and a faster attainment of target goals was seen. Infection rates did not differ between the groups treated traditionally and the group treated with the reduced-fasting protocol. Reduced fasting before procedures should continue to be explored.

Role of Nurses in the Prevention of In-Hospital Malnutrition

Nurses are poised to have a great impact on patient care by ensuring the adequacy of delivered enteral nutrition. Critical care nurses spend more time at the bedside with patients than any other health care provider, allowing the nurse to monitor the amount of enteral nutrition delivered and to monitor and treat complications associated with enteral feedings.

Nurses should question potentially unnecessary interruptions in feedings. It may be possible to eliminate or reduce the time spent without enteral nutrition after consultation with the multidisciplinary team. Confirmation of timing for procedures that require the interruption of enteral nutrition to limit the number of hours the patient remains unable to receive feedings is important because doing so allows the patient to receive enteral nutrition as long as possible. Nurses should also ensure a timely resumption of enteral feeding when interruptions are no longer necessary. When attempting enteral access placement, coordination with auxiliary services such as radiology to obtain timely radiographs to confirm placement is key. The use of alternative methods may diminish the time spent in blind placement attempts.

Further exploration of methods to reduce time spent without enteral nutrition such as reduced fasting time before procedures or extubations is warranted. Exploration of alternative methods of continuous enteral feeding, including increased hourly rates to compensate for predicted losses in feeding volumes and compensatory increases in hourly rate to make up for experienced losses in feeding volumes, should also be performed.

Conclusion

Critically ill patients are at increased risk for malnutrition because of metabolic disturbances experienced during critical illness and impaired delivery of nutrients. Malnutrition is common in critically ill patients and is associated with poor outcomes for patients and increased health care expenditures. Interventions and strategies to diminish time spent without enteral feeding, including HOB elevation during positioning and provision of nursing care, the use of prokinetics when medically appropriate, GRV assessment, consideration of postpyloric feeding access, and use of a nutrition support protocol can help nurses to improve patients’ outcomes.

Financial Disclosures

None reported.

Letters

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